

## INDIAN INITIATIVE IN ADOPTION OF SMART GRID TECHNOLOGY (A CASE STUDY OF PUDUCHERRY FIRST PILOT PROJECT)

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### ABSTRACT

Smart grid is a modernized electrical grid that uses information & communication technology between supplier & consumer interaction in a automated fashion to improve system efficiency, reliability, focusing in distribution sector which is suffering from high transmission losses. In this technology consumers' participation is significantly used for energy management, grid management viz peak load, outage management, demand side management to improve the quality supply to the consumer. There is bilateral communication between consumer & supplier based on information fed in the system. Smart grid technology is adopted worldwide as cost effective & way to quality supply to the consumer. Top 10 advanced countries which have implemented this technology have benefited in a significant manner.

India has taken an initiative to verify the benefits of smart grids technology in 14 pilot projects located in all the 5 regional grids. Puduchery being India's first pilot project which has started on 2<sup>nd</sup> march 2013 by signing a MOU between Power Grid Corporation & Puduchery Electricity Department. Government of India has also setup smart grid task force to monitor the progress of pilot projects by taking 5 working groups namely:

**Working Group 1:** Aimed for trials & pilots on new technological advances.

**Working Group 2:** Will monitor loss reduction & theft, data gathering & analysis.

**Working Group 3:** Power to rural areas & its reliability & quality, power to urban areas.

**Working Group 4:** Distributed generation & renewable integration with power grid & its impact.

**Working Group 5:** Physical cyber security & standardization of smart grid technology.

Smart grid technology involves core major milestones.

1. Advanced metering infrastructure.
2. Advanced distribution operation.
3. Advanced transmission operation.
4. Advanced asset management.

By operating in sequence, milestones can be achieved in most efficient & seamless operation in the grid system. In this paper details of AMI infrastructure & implementation methodology is discussed to obtain numerous benefits of smart grid technology which is being implemented in our country. Smart Grid technology ensure optimum energy use & supply enable better planning for outage response & recovery facilitate the integration of heterogeneous technology around the grid, such as renewable energy system, electrical Vehicle net works & smart home, smart energy grids encounters enormous engineering challenges. Spot billing fault reporting remote metering & substation operation. Consumers servicing through internet & telephone call centers.

**KEYWORDS:** Information & Communication Technology Smart Grid Technology, Modernization of Electrical Grid, Worldwide Adoption & Working Groups

## INTRODUCTION

### About Puducherry

- It is capital of Puducherry State under Union Territory.
- It has a population of 12, 44,464 as per 2011 census.
- It is the union territory consisting of 4 small unconnected districts namely Pondicherry, Karaikal, Yaman, Mahe.
- City of Puducherry was designed based on French architecture with perpendicular streets.
- State Bird –Koel
- State Animal-Squirrel
- State Flower – Cornival
- State Tree – Bael.

### 33 MW Gas Power Plant In Karikel

- Puducherry has Geographical area of 293 Sqkms.
- Karaikel 160 Sqkms, Mahe-9 Sq kms, Yaman-30 Sq kms.
- All districts are located on coastal areas.
- Puducherry and Karaikel are near Tamilnadu coastal, Yaman near AP, Mahe near Kerala.
- Linguistics – Tamil 89%, Malayalam -4.8%, Telugu-2.9% and others-3%.
- From year 1673- 1954 it was called as French India.
- India's per capita consumption is 900 units per Year, while that of Puducherry state consumption is 1800 units /year.
- India's installed capacity in power generation is 2, 11,000 MW, while Puducherry's is 280 MW (as on January 2013).
- There are 2,30,000 electricity consumers, out of which 87K shall be smart consumers in next 5 years.
- At present, around 1400 consumers are installed with smart meters.
- Power Grid Corporation India Ltd Signed MOU on 2nd March 2013 with Puducherry Electricity Dept to implement First Smart Grid Project in the Country on Pilot Basis.
- The Govt. of India has setup Smart Grid Task Force to monitor the Progress. This would be extended to total fourteen city of the country (refer table 1). This Smart Grid Pilot Project would Cost 77 cores for Puducherry Project, out of which 25 Cores will be given by Central government & 52 crore would by State Govt. of Pondicherry.
- This Project will involve the Installation of advanced metering infrastructure in Synchronous with central data control centers.

- This would avail exact billing amount at any point of time and accordingly Electricity board would monitor power uses and detect mall practices or power theft.
- Excepted that electricity board would generate additional revenue of 12.25 Crores per annum without any investment This paper will give us present status of project of our country and whole world. This will give us infrastructure and the implementation procedure and finally the benefits of this Technology. This paper will describe Indian task force and working groups which have been constituted to take up different task related to SMART GRID activities.

### Standard and Spectrum

- WG1 – Trials/Pilot on new technologies.
- WG2 – Loss reduction and theft, data gathering and analysis.
- WG3 – Power to rural areas and reliability & quality of power to urban areas.
- WG4 – Dist Generation & renewable.
- WG5 \_ Physical cyber security
- This is a **list of states of south India & complete India** by **installed capacity of power utilities** with electricity generation mode break-up as of 30-06-2012 and 31-01-2013 <sup>[1][2]</sup> with figures in millions of watts (Megawatts).

**Table 1**

| Rank | State/Union Territory | Total Installed Capacity | Total Thermal | Nuclear  | Hydro     | Renewable Energy* |
|------|-----------------------|--------------------------|---------------|----------|-----------|-------------------|
| 16   | Kerala                | 3,836.48                 | 1,687.94      | 95.60    | 1,881.50  | 171.44            |
| 23   | Goa                   | 418.32                   | 362.47        | 25.80    | 0.00      | 30.05             |
| 25   | Puducherry Territory  | 279.66                   | 260.35        | 19.28    | 0.00      | 0.03              |
| 3    | Tamil Nadu            | 18,382.13                | 8,217.33      | 524.00   | 2,137.20  | 7,503.60          |
| 4    | Andhra Pradesh        | 16,817.13                | 11,771.08     | 275.78   | 3,734.53  | 1,035.74          |
| —    | India                 | 211,766.22               | 141,763.88    | 4,780.00 | 39,416.40 | 24,856.14         |

### INDIA SMART GRID TASK FORCE

The **India Smart Grid Task Force** is an inter ministerial group and will serve as government focal point for activities related to SMART GRID.

- The Main functions of ISGTF pertaining to Smart Grid are:
- To ensure awareness coordination and integration of diverse activities related to Smart Grid Technologies.
- Practices & services for research & development of SMART GRID.
- Coordination and integrate other relevant inter governmental activities.
- Collaborate on interoperability framework.
- Review & validate recommendations from India Smart Grid Forum etc.

- This Project Will Involve the Installation of advanced metering infrastructure in synchronous with central data control centers.
- This would avail exact billing amount at any point of time and accordingly Electricity board would monitor power uses and detects mall practices or power theft. Expected that electricity board would generate additional revenue of 12.25 Cr per annum without any investment.

## FEATURES OF SMART GRID

The smart grid represents the full suite of current and proposed responses to the challenges of electricity supply. Because of the diverse range of factors there are numerous competing taxonomies and no agreement on a universal definition. Nevertheless, one possible categorization is given here.

Reliability Flexibility in network topology. Efficiency, Load adjustment, Peak curtailment/leveling and time of use pricing, Sustainability, Efficiency, Load adjustment, Peak curtailment/leveling and time of use pricing, Sustainability, Market-enabling, Demand response support, Platform for advanced services, Provision megabits, control power with kilobits, sell the rest.

### Reliability

The smart grid will make use of technologies that improve fault detection and allow self-healing of the network without the intervention of technicians. This will ensure more reliable supply of electricity, and reduced vulnerability to natural disasters or attack.

## COMPONENTS OF SMART GRID CONTROL CENTER AT PUDUCHERRY

- Smart Meters
- Data Concentrator Unit (DCU)
- Meter Data Acquisition System( MDAS)
- Meter Data Management System ( MDMS)
- Outage Management System( OMS)

These components will interact with SACADA system & billing section. Presently 1400smart meters from different manufacturers along with 6 DCU are working on three different communication techniques viz. PLC(POWER LINE CARRIER), RF-1 ( RADIO FREQUENCY)865 MHz,RF-2 4GHz.Data from smart meters are fed to MDAS and further MDMS through GPRS system.DCU will work in group of 40 to 50 meters. Data from smart meters are regularly monitored & analyzed to have better Insight into consumer use pattern.

## SMART HOMES

Smart homes use advanced technological solution to undertake more rational electricity consumptions of home appliances viz. television, fridge, microwave, heaters, gysers, mixers, air conditioners etc which can be operated remotely. This will enable us to save more energy & thereby saving our natural resources. A model of smart home was established at Puduchery near Smart Grid Control Center, to demonstrate its functionality in the Smart Grid Network.

## SMART GRID BENEFITS

The smart grid will accelerate adoption of new technologies, create jobs, provide digital quality power, lower power delivery costs, reduce blackouts and brownouts, cut pollution, improve energy efficiency, and promote growth of distributed and renewable resources.

- An intelligent, self-healing grid that anticipates and thwarts natural or man-made disruptions and dramatically reduces costly blackouts and power disturbances,
- A more economical grid that has far less need for expensive peak power generators and delivery infrastructure,
- A cleaner grid that can more rapidly bring on line renewable and cleaner distributed generation.
- **Microgrids** : Smart energy management technologies also open up possibilities for microgrids not connected to the larger grid. They might supply DC power instead of standard AC, which is a tremendous energy and cost saver since digital equipment which typically runs on DC contain expensive power conversion equipment. Electronic intelligence will automatically operate micro grids in conjunction with building energy management systems and smart equipment, thus reducing operating costs.

## SMART GRID WORLD WIDE

Worldwide many national governments are encouraging smart grid initiatives as a cost effective way to modernize their power system infrastructure. While enabling integration of low carbon energy resources ( like solar ,wind, biomass) & customer participation in the system management.

## UNITED STATES OF AMERICA

### Under American Recovery & Reinvestment Act (ARRA) 2009

A combined investment of over 8 billion \$ in smart grid capabilities is expected.

**Table 2: List of Top 10 Smart Grid Projects in USA are Based on Number of Meters Installed is Given Below**

| S.No. | Plant Name  | Capacity  |
|-------|---|-----------|
| 1.    | Florida Power & Light Company ( Energy Smart Florida )        | 23,59,736 |
| 2.    | Center Point Energy Houston Electric LCC (Smart Grid Project) | 21,25,678 |
| 3.    | NV Energy   | 9,02,272  |
| 4.    | Detriot Edison Company ( Smart Current)                       | 6,25,468  |
| 5.    | Sacramento Muncipal Utility District(Smart Sacramento         | 6,17,502  |
| 6.    | Central Marine Power Company (CMP Advanced Metering)          | 6,06,164  |
| 7.    | Duke Energy Smart Grid Development                            | 4,67,619  |
| 8.    | Salt River Project  | 4,31,913  |
| 9.    | Idaho Poma Company ( IPC-Smart Grid Project)                  | 3,80,928  |
| 10.   | Pepco Holiday INC-DC(Smart Grid Project)                      | 2,57,224  |

## SOUTH KOREA

### JEJU SMART GRID DEMONSTRATION PROJECT (3 STAGE PROGRAM)

Ist Stage Testing station - 2012

IInd Stage S G Infrastructure focus on consumers between Korea's Metropolitan area-2020

III rd Stage Nationwide Smart Grid would be completed by 2030.

## JAPAN

### MINISTRY OF ECONOMY TRADE & INDUSTRY

National Committee 2008-2009 T&D infrastructure 2009-2010

Tohoku Earthquake March 2011

## UNITED KINGDOM

### SMART GRID INITIATIVE

SMART GRID GAS METRES 6, 00, 000 (0.6 million already installed in 2012)

53 MILLION to be installed by 2019

## MALAGA (SPAIN)

### SMART CITY PROJECT

Malaga was the first European trial city in 2009

Local residents will be having smart meters-can manage remotely & make consumption more efficient - smart houses.

**Table 3: Comparison between Exists System & Smart Grid System**

| S.No. | Conventional                       | Smart System                 |
|-------|------------------------------------|------------------------------|
| 1.    | Electromagnetic metering           | Digital metering             |
| 2.    | One way communication              | Two way communication        |
| 3.    | Centralized Generation             | Distributed Generation       |
| 4.    | Few sensors in the system          | Sensor throughout the system |
| 5.    | Manual monitoring & Restoration    | Self Monitoring & Healing    |
| 6.    | Frequent Interruptions & Blackouts | Adaptive IS Landing          |
| 7.    | Limited Control                    | Pervasive Control            |
| 8.    | Passive Consumers                  | Active Consumers             |



**Figure 1: Puducherry, Karaikal, Mahe & Yanam Map**



Figure 2: Pondicherry City Map

Table 4

Smart Grid Pilot Projects in Power Distribution Sector in India

| S.No. | Utility Name            | Area Proposed                                 | Functionality Proposed*        | Initial Consumer Base |
|-------|-------------------------|---|--------------------------------|-----------------------|
| 1     | CESC, Mysore, Karnataka | Mysore Additional City Area Division          | AMI R, AMI I, OM, PLM, MG/ DG  | 21,824                |
| 2     | APCPDCL, Andhra Pradesh | Jeedimetla Industrial Area                    | AMI R, AMI I, PLM, OM, PQM     | 11,904                |
| 3     | APDCL, Assam            | Guwahati Project Area                         | PLM, AMI R, AMI I, OM, DG, PQM | 15,000                |
| 4     | UGVCL, Gujarat          | Naroda / Deesa                                | AMI R, AMI I, OM, PLM, PQM     | 39,422                |
| 5     | MSEDCL, Maharashtra     | Baramati, Pune                                | AMI R, AMI I, OM               | 25,629                |
| 6     | UHBVN, Haryana          | Panipat City SubDivision                      | AMI R, AMI I, PLM              | 30,544                |
| 7     | TSECL, Tripura          | Electrical Division No. I, Agartala           | AMI R, AMI I, PLM              | 46,071                |
| 8     | HPSEB, Himachal Pradesh | ESD Kala Amb Under Electrical Division, Nahan | AMI I, OM, PLM, PQM            | 650                   |
| 9     | Puducherry              | Div 1 of Puducherry                           | AMI R, AMI I                   | 87,031                |
| 10    | JVVNL, Rajasthan        | VKIA Jaipur                                   | AMI R, AMI I, PLM              | 2,646                 |
| 11    | CSPDCL, Chattisgarh     | Siltara, Chattisgarh                          | AMI I, PLM                     | 508                   |
| 12    | PSPCL, Punjab           | Mall Mandi City Sub-Division Amritsar         | OM                             | 9,000                 |
| 13    | KSEB, Kerala            |   | AMI I                          | 25,078                |
| 14    | WBSEDCL, West Bengal    | Siliguri town, Darjeeling District            | AMI R, AMI I, PLM              | 4,404                 |

\*Legend:

| S.No. | Functionality Abbreviation | Functionality  |
|-------|----------------------------|--|
| 1     | AMI R                      | Advanced Metering Infrastructure for Residential Consumers |
| 2     | AMI I                      | Advanced Metering Infrastructure for Industrial Consumers  |
| 3     | OM                         | Outage Management  |
| 4     | PLM                        | Peak Load Management                                       |
| 5     | PQM                        | Power Quality Management                                   |
| 6     | MG                         | Micro Grid   |
| 7     | DG                         | Distributed Generation                                     |

## SMART GRID

Power grid has appointed a panel of experts to advise upon WAMS Implementation in Indian power system.

PMU installation as pilot project for each region in the country underway

Northern Region (9 PMUS) already installed.

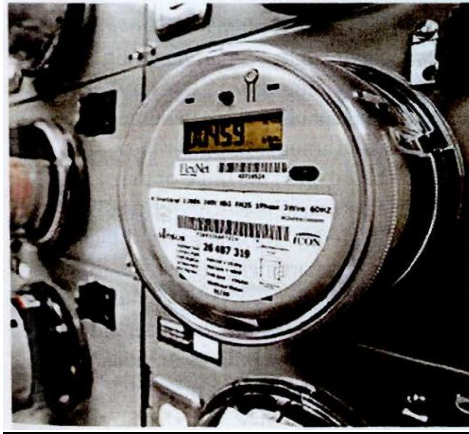
Northern Region (14 PMUS).

Southern Region (6 PMUS).

Northern Eastern Region (6 PMUS)

Western Region (6 PMUS).

Eastern Region (8 PMUS).



**Figure 3: Smart Grid Digital Meter**

## CONCLUSIONS

The use of Smart Grid System makes it robust, stable. Smart grids in a long run can reduce power cuts in India .Currently there are 14 pilot projects (**Details in Table 4**) proposed out of which Puducherry project is first of its kind and completed with around 1400 smart meters installed in Ist Phase by 30<sup>th</sup> November 2013 .The results of the same are being analyzed in Industrial & residential sectors. The basic objective has been achieved in reduction of Aggregate Transmission & Commercial losses (AT & C) from 26.16% to 8.88%. Consumers are aware of the consumption & Billing procedure through Smart Metering Infrastructure. In the smart grid project of Puducherry power grid has developed consumer utility center interactive with pilot smart grid project which has covered the following advantages. Integration of multiple forms of renewable energy sources namely solar, wind & fuel cells. Smart metering & control of electricity through advanced metering infrastructure. Power quality management. Peak load management .Outage management system. Micro grid .Storage technology. Electrical vehicle station. The above projects are to implement social security system, transport system , waste management , E-Public services ,smart building & smart homes.

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